Suspended Organic Particle concentration and stable C and N isotopes from the Eastern Tropical North Pacific in April 2018 (R/V Roger Revelle RR1805) and October 2019 (R/V Kilo Moana KM1920)

Website: https://www.bco-dmo.org/dataset/948637
Data Type: Cruise Results
Version: 1
Version Date: 2025-01-17

Project
» Dimensions: Diversity, assembly and function of microbial communities on suspended and sinking particles in a marine Oxygen Deficient Zone (ETNP_ParticleOmics)

Program
» Dimensions of Biodiversity (Dimensions of Biodiversity)

Contributors	Affiliation	Role
Fuchsman, Clara	University of Maryland Center for Environmental Science (UMCES/HPL)	Principal Investigator
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Suspended Organic Particle Carbon and Nitrogen concentrations and stable C and N isotopes were obtained from the Eastern Tropical North Pacific on the R/V Revelle cruise RR1805 in April 2018 and the R/V Kilo Moana cruise KM1920 in October 2019. R/V Revelle cruise RR1805 sampled two stations in 2018: St P2 (16.9ºN 107ºW) and St P1 (20.3 °N 106.1°W). These two stations included an anoxic Oxygen Deficient Zone from 105-820 m for St P2 and 68-800 m for St P1. The R/V Kilo Moana cruise KM1920 sampled two stations in 2019: St P2 (16.9°N 107°W) and St P3 (21.8°N 109.9°W). These two stations included an anoxic Oxygen Deficient Zone from 110-820 m for St P2 and 160-650 m for St P3. St P3 is at the Northern Edge of the Oxygen Deficient Zone. St P2 is offshore in the core of the Oxygen Deficient Zone, and St P1 is on the continental slope. During both cruises, water for bulk suspended particulate organic C and N analyses was obtained from Niskin bottles on a CTD rosette and vacuum-filtered it onto pre-combusted GF/F filters. Samples were wafted with HCl to remove carbonate and sent to the UC Davis Stable Isotope Facility (Davis, CA) for C and N analysis utilizing an elemental analyzer attached to an isotope ratio mass spectrometer. The samples were obtained to determine whether organic matter concentrations increased and isotopic composition changed at the secondary chlorophyll maximum in the Oxygen Deficient Zone and at the zooplankton/forage fish vertical migration depth in the Oxygen Deficient Zone. St P2 and St P1 had a secondary chlorophyll maximum and St P3 did not. Samples were collected and data were analyzed by Clara Fuchsman of Horn Point Laboratory, a part of the University of Maryland Center for Environmental Science.

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- Funding

Coverage

Location: Eastern Tropical North Pacific Oxygen Deficient ZoneSt P2 (16.9ºN 107ºW), St P1 (20.3 ºN 106.1ºW) and St P3 (21.8°N 109.9°W)
Spatial Extent: **N**:21.86 **E**:-106 **S**:16.81 **W**:-109.98
Temporal Extent: 2018-04-17 - 2019-10-15

Dataset Description

These data were supported by NSF award DEB-1542240 and Horn Point Laboratory startup funds.

Results publication in review:
Fuchsman, C.A. and Cram, J.A. (in review) Size fractionated suspended organic carbon and nitrogen from the offshore Eastern Tropical North Pacific Oxygen Deficient Zone suggest contributions of picocyanobacteria and vertically migrating metazoans to organic matter. Global Biogeochemical Cycles
*preprint available at ESS Open Archive (Fuchsman & Cram
2024, doi:10.22541/essoar.173046855.50289201/v1)

Methods & Sampling

Samples were obtained from the Eastern Tropical North Pacific on two cruises. The R/V Revelle cruise RR1805 sampled two stations in April 2018: St P2 (16.9ºN 107ºW) and St P1 (20.3 ºN 106.1ºW). The R/V Kilo Moana cruise KM1920 sampled two stations in October 2019: St P2 (16.9ºN 107ºW) and St P3 (21.8°N 109.9°W).

For depth profiles of bulk suspended particulate organic C and N analyses, 4 L or 10 L (for samples from >300 m) of water was obtained from 12 L Niskin bottles on a CTD rosette, using the spigot of the bottle. Exact volumes were recorded. Water was vacuum filtered onto pre-combusted (400°C), 25 mm diameter, GF/F filters and then frozen. Within a year from collection, samples were wafted with HCl overnight to remove carbonate, dried at 40°C, packed into nested silver and tin capsules, and sent to the UC Davis Stable Isotope Facility (Davis, CA) for C and N analysis utilizing an elemental analyzer (Elementar Vario EL Cube) attached to an isotope ratio mass spectrometer (Isoprim VisION). Blank combusted GF/F filters were included in analyses and did not show measurable material.

Data Processing Description

The data output from UC Davis was ug C and ug N, as well as the stable isotopes. Microsoft excel was used to convert ug to uM, using the volume of water filtered.

BCO-DMO Processing Description

* Sheet 1 of submitted file "ETNP_2018_2019_POM.xlsx" was imported into the BCO-DMO data system for this dataset. Will appear as Data File: 948637_v1_etnp-pom_2018-2019.csv (along with other download format options).
** In the BCO-DMO data system missing data identifiers are displayed according to the format of data you access. For example, in csv files it will be blank (null) values. In Matlab .mat files it will be NaN values. When viewing data online at BCO-DMO, the missing value will be shown as blank (null) values.

* Completely blank rows removed within table.

* Date converted to ISO 8601 format

* Lat lon converted to decimal degrees (south and west are negative, degree symbols and directional NSEW removed)

* Supplemental reference tables were attached without format changes.

Problem Description

No known problems.

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Data Files

File
Suspended organic C and N concentrations and stable isotopes for the ETNP in 2018 and 2019 filename: 948637_v1_etnp-pom_2018-2019.csv (Comma Separated Values (.csv), 5.42 KB) MD5:32f243f060d31b759990cba5192d05d6 Primary data file for dataset ID 948637, version 1. Suspended organic C and N concentrations and stable isotopes from the Eastern Tropical North Pacific Oxygen Deficient Zone in April 2018 and October 2019. Samples were obtained from Niskin bottles and filtered onto GF/F filters.

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Supplemental Files

File
Relevant standard information for the 2019 ETNP data filename: ETNP_2019_POM_standard_information.xlsx (Microsoft Excel, 10.90 KB) MD5:a8170b7b67c6f5b925b7789030fd1e0d Comparison of relevant reference isotopic values to their official values for the 2019 dataset. Data is from the UC Davis Stable Isotope Facility. Asterisk (*) Means and standard deviation excludes references below limit of quantification.
Relevant standard information the 2018 ETNP data filename: ETNP_2018_POM_Standard_information.xlsx (Microsoft Excel, 10.90 KB) MD5:b2470d753f8a8e75e717d9410b50df1c Comparison of relevant reference isotopic values to their official values for the 2018 dataset. Data is from UC Davis Stable Isotope Facility. Asterisk (*) Means and standard deviation excludes references below limit of quantification.

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Related Publications

Fuchsman, C. A., & Cram, J. A. (2024). Size fractionated suspended organic carbon and nitrogen from the offshore Eastern Tropical North Pacific Oxygen Deficient Zone suggest contributions of picocyanobacteria and vertically migrating metazoans to organic matter. https://doi.org/10.22541/essoar.173046855.50289201/v1
Results

Fuchsman, C. A., Duffy, M. E., Cram, J. A., Huanca-Valenzuela, P., Gregory, B. P., Plough, L., Pierson, J. J., Fitzgerald, C. L., Devol, A. H., & Keil, R. G. (2024). Contributions of Vertically Migrating Metazoans to Sinking and Suspended Particulate Matter Fuel N2 production in the Eastern Tropical North Pacific Oxygen Deficient Zone. https://doi.org/10.22541/essoar.172745075.56787778/v1
Results

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Parameters

Parameter	Description	Units
Cruise	cruise number	unitless
station	station sampled	unitless
Cast	CTD cast	unitless
latitude	location sampled (latitude)	decimal degrees
longitude	location sampled (longitude)	decimal degrees
Date	date sampled (ISO 8601 format)	unitless
depth	depth sampled	meters (m)
d13C_VPDB	isotopic composition of C (d13C with respect to reference standard VPDB="Vienna Pee Dee Belemnite")	permil (0/00)
Carbon	concentration of organic C. Detection limit for C is 30 ug.	micromolar (uM)
d15N_Air	isotopic composition of N (d15N with respect to reference standard air).	permil (0/00)
Nitrogen	concentration of organic N. Detection limit for N is 5 ug	micromolar (uM)
C_to_N	ratio of molar carbon to nitrogen concentrations (C:N)	unitless

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Elementar Vario EL Cube elemental analyzer
Dataset-specific Description	At the UC Davis Stable Isotope Facility (Davis, CA), they used an elemental analyzer (Elementar Vario EL Cube) attached to an isotope ratio mass spectrometer (Isoprim VisION).
Generic Instrument Description	A laboratory instrument used for quantifying organic elements. It can measure C, H, N and S and optionally O, Cl and TIC. It was first developed in 2006 as a successor to the vario EL III. It uses a high-temperature combustion unit that is able to complete sample digestion at up to 1200 deg C (or 1800 deg C at the point of combustion when tin foil is used) and a jet injection of oxygen directly to the sample during combustion. Separation of gas components are performed on up to 3 gas-selective columns which trap gases until they are heated up and the prior gas peak has reached the baseline during detection. It uses a Thermal Conductivity Detector (TCD) as standard. An infrared (IR) detector for sulfur and oxygen and electrochemical detector for chlorine are optionally available. The instrument can measure C / N elemental ratios of up to 12,000:1 and provides an elemental detection limit of < 40 ppm (TCD).

Dataset-specific Instrument Name	Isoprim VisION
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	At the UC Davis Stable Isotope Facility (Davis, CA), they used an elemental analyzer (Elementar Vario EL Cube) attached to an isotope ratio mass spectrometer (Isoprim VisION).
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

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Deployments

KM1920

Website	https://www.bco-dmo.org/deployment/849547
Platform	R/V Kilo Moana
Start Date	2019-10-02
End Date	2019-10-22
Description	More information is available from the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/km1920 Cruise DOI: 10.7284/908379

RR1805

Website	https://www.bco-dmo.org/deployment/779193
Platform	R/V Roger Revelle
Start Date	2018-04-14
End Date	2018-05-02
Description	More information is available at R2R: https://www.rvdata.us/search/cruise/RR1805

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Project Information

Dimensions: Diversity, assembly and function of microbial communities on suspended and sinking particles in a marine Oxygen Deficient Zone (ETNP_ParticleOmics)

Coverage: Eastern Tropical North Pacific

Extracted from the NSF award abstract:

Marine oxygen deficient zones (ODZs) are waters that are functionally devoid of oxygen. Without oxygen, some microbes are capable of converting nitrogen in the water into N2 gas, which then leaves the ocean and enters the atmosphere. This loss of an important nutrient from the ocean has impacts on phytoplankton growth and marine food webs. While oxygen deficient zones occupy a very small percentage of the ocean, they account for as much as half of the oceanic loss of N as N2. Moreover, the size of these regions is predicted to expand during this century due to climate change. The microbes that are capable of producing N2 gas are extremely diverse, and use several different biochemical pathways to carry out this process. They may occur both free-floating in the water and attached to small particles that are suspended or sinking from the surface waters and providing them a carbon source. However the importance of these two lifestyles (free-living vs particle attached) in terms of contributions to N loss from the oceans is not well understood. This project will identify the major organisms that result in N2 gas production on both suspended and sinking particles, the chemical reactions they carry out, and the rates at which this occurs. This information will be used to improve global climate models to better predict rates of N loss in a future ocean. Elementary and middle school teachers enrolled in a Masters in Science for Science Teachers program will be involved in the project and the graduate students and post-doctoral researchers supported by the project will have opportunities to participate in their classrooms. Underserved populations will also be integrated into the research at the undergraduate and middle school level through a series of summer internships.

ODZs have very complex elemental cycles, implying great microbial diversity. Intertwined with the microbial complexity of ODZ regions is the relatively unexplored interplay between free-living bacteria and those living on either suspended or sinking particles. Determining how these communities and niches interact and relate is one of the most challenging components of ODZ system studies today. Current climate models portray the dynamics of particles in the ODZs and throughout the deep ocean through prescribed functions based on sparse data from the oxic ocean with microbes represented only by the net chemical reactions of the community. However, in reality a phylogenetically and metabolically diverse group of microbes, likely acting in consortia, are responsible for the nitrogen transformations that ultimately result in the production of N2. To explore the processes maintaining the genetic diversity and functional redundancy in N loss processes, four research areas will be integrated: the community phylogenetic diversity (both taxonomic and genomic diversity) the genetic diversity of the proteins that carry out key N transformation processes (as seen through quantitative proteomics), the resulting biogeochemical functions (15N labeled nitrogen transformation rate measurements) and predictions about how this diversity and corresponding function may change in response to climate change (biogeochemical modeling). The approach will be to assay both phylogenetic (16S rRNA tag sequencing) and functional genetic diversity (genomics) on sinking particles collected using large-volume sediment traps. Phylogenetic and genomic studies will be intimately tied to measurements of activity - who is doing key biogeochemical transformations (proteomics) and what are the in situ rates at which they are doing them (using novel incubation systems). Data will then be used to model how diversity and corresponding function change on a range of time and space scales, from the sinking of a single particle to seasonal cycles. To understand the relationship of community diversity and function on suspended and sinking particles, a series of three cruises will be conducted in the Eastern Tropical North Pacific ODZ.

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Program Information

Dimensions of Biodiversity (Dimensions of Biodiversity)

Website: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503446

Coverage: global

(adapted from the NSF Synopsis of Program)
Dimensions of Biodiversity is a program solicitation from the NSF Directorate for Biological Sciences. FY 2010 was year one of the program. [MORE from NSF]

The NSF Dimensions of Biodiversity program seeks to characterize biodiversity on Earth by using integrative, innovative approaches to fill rapidly the most substantial gaps in our understanding. The program will take a broad view of biodiversity, and in its initial phase will focus on the integration of genetic, taxonomic, and functional dimensions of biodiversity. Project investigators are encouraged to integrate these three dimensions to understand the interactions and feedbacks among them. While this focus complements several core NSF programs, it differs by requiring that multiple dimensions of biodiversity be addressed simultaneously, to understand the roles of biodiversity in critical ecological and evolutionary processes.

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Funding

Funding Source	Award
NSF Division of Environmental Biology (NSF DEB)	DEB-1542240

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